

$(1 + (3))$ , where  $(3)$  is constant. Therefore,  $\frac{\sigma' a'^3}{(\epsilon' + \mu') A'^3}$  will become  $\frac{\sigma a^3}{(\epsilon + \mu) A^3} \times (1 + 3(1)) \cdot (1 + 3(2)) \cdot (1 - (3)) \cdot (1 - 3(1)) = \frac{\sigma a^3}{(\epsilon + \mu) A^3} \times (1 + 3(2) - (3))$ . And to form  $\frac{\sigma' a'^3}{(\epsilon' + \mu') A'^3} \cdot \frac{a'}{A}$ , we must multiply the last expression by  $\frac{a}{A} (1 + (2) - (1))$ , and it becomes  $\frac{\sigma a^3}{(\epsilon + \mu) A^3} \cdot \frac{a}{A} \times (1 - (1) + 4(2) - (3))$ .

No general rule can be given for the appropriation of contingent symbols to terms. But every principal coefficient (as the coefficients of elliptic equation, evection, variation, annual equation, inclination, evection in polar distance, and many much smaller coefficients,) must have its independent symbol of contingent correction.

The first part of the process of applying these principles to the Lunar Theory will consist in developing the expressions of Articles VIII., IX., X., by substitution in them of Delaunay's numerical values of  $\frac{a}{r}$ ,  $v$ ,  $l$ , and in ascertaining how nearly these values will satisfy the three equations of Article V.

I have developed, numerically, the expressions for all the requisite powers of  $\frac{r}{a}$  and  $\frac{a}{r}$ , and I am proceeding with the development of  $\sin l$  and various powers of  $\cos l$ .

1874, *January 9.*

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*Additional Notes concerning Sir William Herschel's Double Stars.*  
By S. W. Burnham, Esq.

(Communicated by Mr. Dunkin.)

I have given some attention, more particularly within the last few months, to the telescopic examination of Double Stars with reference to which there exists some uncertainty as to place, magnitude, position-angle, and distance, identity with other double stars, &c. There is a large number of such objects, several hundred perhaps, principally from the Catalogues of the two Herschels, which require or may require correction in some of these respects. Some have been found to be out of their

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assigned places, and very many ascertained to be identical with stars heretofore regarded as distinct objects.

At the time of preparing the paper on "Errors and Omissions in the Catalogue of Sir William Herschel's Double Stars" (*Monthly Notices*, xxxiii. No. 9, Supplementary Number), I was not aware of a communication on the same subject by Sir John Herschel (*Monthly Notices*, xxviii. p. 151), so that a few of my corrections had already been noted.

The following, some of the results of an examination or search for the stars referred to, relate for the most part to their identity. In a few instances, as will be seen, a considerable error in place has been detected. All the places given from Herschel's Catalogue (*Memoirs of the R. A. S.*, xxxv.), or otherwise, are for 1880.—

#### H. I. 47.

No measures of distance:  $P=336^{\circ}8$ . My estimates are:  $P=330^{\circ}$ :  $D=2\frac{1}{2}''$ : Mags. 8,  $8\frac{1}{4}$ . The place of this star from the *Washington Transit Zones* (No. 9, Z. 205) makes Herschel's declination  $7'$  too large. After these observations, I found that this pair was identical with H. 5252 (*Cape Observations*), where  $P=328^{\circ}0$ :  $D=2''\cdot 1$ : Mags. 8, 8. The place from *Cape Observations* agrees exactly with that from the *Washington Zones*.

#### H. I. 60.

$P=286^{\circ}8$ . No measures of distance. Herschel II. says, "It is barely possible that this may be  $\Sigma$  2441 with a change of  $5^{\circ}$  in position, but the place disagrees by  $18'$  in P. D." I have not been able to find any pair nearer than  $\Sigma$  2441, which answers the description. H. 1366 has the same declination as H. I. 60, but is about  $3^m p$ . This is a very faint pair, and not likely to be Herschel's, even if the position-angle corresponded. ( $P=57^{\circ}8$ :  $D=10''\pm$ : Mags. 9, 10, 12). About  $2\frac{1}{2}^m p$ , the last is an 8 mag. star with a distant, very minute double companion. There is very little, if any, doubt of the identity of H. I. 60 with  $\Sigma$  2441.

#### H. I. 77.

No measures of distance are given by Herschel. He makes  $P=7^{\circ}6$ . I have looked up this pair, a very pretty double, and estimate  $D=2''$ :  $P=10^{\circ}$ .

#### H. I. 90.

I have carefully examined the vicinity, and cannot find any double of Class I. in this place, and no pair nearer than S. 788 and  $\Sigma$  2781.

#### H. III. 20.

$P=329^{\circ}5$ :  $D=7''\cdot 6$ . "Identification very precarious from vagueness of description." Although the place given is  $2^m p$ , and  $24'n$  of  $\Sigma$  1838, they are undoubtedly the same. Struve gives:  $P=333^{\circ}8$ :  $D=9''\cdot 04$ .

## H. III. 42.

No measures in Herschel.  $\Sigma$  246 is  $3^m f$  and  $5^n$ , and the only pair to be found in the immediate vicinity.

## H. III. 52.

$P=52^\circ.9$ :  $D=13''.67$ . "Identification precarious; by bare possibility S. 465." This is certainly  $\Sigma$  630 (=S. 465). Struve gives:  $P=49^\circ.2$ :  $D=14''.0$ . Herschel's place should be diminished  $25^s$  in R.A., and  $28'$  in Declination.

## H. III. 103.

$P=148^\circ.4$ :  $D=12''.97$ . This is  $\Sigma$  2446 (=P. xviii. 302) where  $P=154^\circ.5$ :  $D=10''.13$ . There is a second minute companion, not mentioned by either, in the opposite direction, at a distance of  $30''$  or  $40''$ . Herschel's place agrees substantially with Struve's.

## H. IV. 34.

$D=30'' \pm$ . "Near 64 *Aquilæ*. No other indication of place." The only pair found is one in the field with *np* 64 *Aquilæ*.  $P=190^\circ$ :  $D=30''$  or more: Mags. 9, 10.

## H. IV. 127.

$P=339^\circ.9$ :  $D=16''.55$ . In the Catalogue this is called Piazzi xviii. 274 (that star being  $\Sigma$  2434), and in his list of corrections Sir John Herschel states explicitly that H. IV. 127 is  $\Sigma$  2434 (=Sh. 285), the place of which had been given in the first instance. Struve's measures of the wide pair of that star are:  $P=147^\circ.0$ :  $D=25''.56$ . Suspecting from the discordance between the measures of Herschel and Struve, that these two stars were not the same, I carefully examined all the stars in the vicinity, and found beyond all question that Herschel's pair was identical with  $\Sigma$  2447. Struve gives:  $P=334^\circ.9$ :  $D=13''.82$ , differing but slightly from the measures of Sir W. Herschel quoted above. The place of H. IV. 127 should therefore be increased  $3^m 48^s$  in R.A. and  $39'$  in Dec.

## H. V. 31.

$D=30''$ . "A choice between two stars, but the preceding the most probable." There are several small stars near this place answering the description in respect to distance, but the absence of the position-angle renders any absolute identification impossible.

## H. V. 103.

"The place that of a star 8 m. in Argelander, very unequivocally indicated." This star is L. 35845, the place of which differs but slightly from Herschel's. It is also correctly given in *Positiones Mediæ*.

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*H. VI. 47.*

R.A. =  $19^h 19^m 9$ ; Dec. =  $+1^\circ 35'$ . No measures. "Identification very precarious." The only pair found is L. 36616, of which  $P=105^\circ$ :  $D=60''$ : Mags.  $7\frac{1}{2}$ ,  $8\frac{1}{2}$ . Reduced from Lalande, R.A. =  $19^h 18^m 49^s$ : Dec.  $+1^\circ 36'$ .

*H. VI. 48.*

R.A. =  $19^h 20^m$ : Dec. =  $+1^\circ 20'$ . No measures. "Identification very precarious." The only double found in the vicinity besides the last is L. 36659.  $P=340^\circ$ :  $D=25''$ : Mags. 9, 11. The place from Lalande is: R.A. =  $19^h 20^m 17^s$ : Dec. =  $+1^\circ 33'$ .

*H. VI. 49 and 50.*

No measures given of these stars, which have the same approximate R.A. with a difference of but  $5'$  in Dec. One of them must be P. xviii. 197, of which Smyth's measures are:  $P=168^\circ 9$ :  $D=99'' 0$ : Mags. 7, 9.

*H. N. 10.*

This star is entered, without measures, as Class III. with the position given as "preceding." Sir John Herschel has given no synonyms, and yet this pair is found in no less than four other double star Catalogues, two of which are by Sir John Herschel himself. The corresponding numbers are: H. N. 10 =  $\Sigma$  C. P. 693 = S. 763 = H. 2996 = H. 3002. South gave:  $P=295^\circ 1$ :  $D=16'' 75$ , and Herschel (2996)  $P=291^\circ 6$ :  $D=15'' \pm$ . The places agree, with the exception of H. 3002, which is about  $4^m$  preceding in R.A. There Herschel gives  $P=120^\circ \pm$ :  $D=25'' \pm$ , which he states were "estimated from a diagram." This will probably explain the reversing of the angle, and the increased distance. He calls it "a very fine double star," but gives no magnitudes. I have very carefully examined on several occasions all the stars within a considerable radius, and I am absolutely certain that these various Catalogues all refer to the same pair. There is something strange about the great difference in the estimated magnitudes by different observers. In the B.A.C. (7202) it is 6 m.; South,  $7\frac{1}{2}$ , 8; Herschel (2996) 9, 9+; in the *Washington Transit Zones*, where it is noted as "a beautiful double star," it is given 9 m. When examined recently the magnitudes appeared to be about as set down by South. In a low-power field  $8'$  directly south I noticed a pretty  $2''$  pair of very minute stars.

*H. N. 18.*

No measures in Herschel, Class II. A rather faint pair, estimated:  $P=250^\circ$ :  $D=5''$ : Mags. 9, 9+.

*H. N. 35.*

No measures; angle "following." Herschel's place is:

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R.A. =  $23^{\text{h}} 31^{\text{m}}.3$ : Dec. =  $-13^{\circ} 45'$ . This is *Aquarii* 355, and its place from Lalande (46271): R.A. =  $23^{\text{h}} 31^{\text{m}} 27^{\text{s}}$ : Dec. =  $-13^{\circ} 43' 34''$ . Estimated,  $P=90^{\circ}$ :  $D=40''$ : Mags. 7, 10.

H. N. 39.

R.A. =  $21^{\text{h}} 14^{\text{m}}.2$ : Dec. =  $+39^{\circ} 13'$ :  $P=120^{\circ}.5$ :  $D=18'' +$  "Place that of the most probable star in Argelander." This is identical with No. 648 of Sir John Herschel's 7-ft. equatoreal measures (*Memoirs of the R. A. S.* xiii.), where it is marked "nova." There  $P=114^{\circ}$ :  $D=26''.45$ : Mags. 7, 11. I find that this is Weisse (2) xxi. 312, from which R.A. =  $21^{\text{h}} 14^{\text{m}} 17^{\text{s}}$ : Dec. =  $+39^{\circ} 15'$ . It is about  $1^{\text{h}} 20^{\text{s}}$  following  $\Sigma 2785$ .

H. N. 63.

R.A. =  $14^{\text{h}} 55^{\text{m}}.6$ :  $D=+54^{\circ} 15'$ . This is  $\Sigma$  C. P. 470; and the place, from *Positiones Medice*, R.A. =  $14^{\text{h}} 56^{\text{m}} 0^{\text{s}}$ : Dec. =  $+54^{\circ} 20'$ .

H. N. 101.

Class III. No measures. Found and estimated,  $P=330^{\circ}$ :  $D=10''$ : mags.  $8\frac{1}{2}$ , 9.

H. N. 102.

$P=300$ ; Class III. In or very near this place is a pair of 10 m. stars.  $P=300^{\circ}$ :  $D=5''$ . I failed to find any other double at all corresponding.

H. N. 110.

Class V. No measures. R.A. =  $19^{\text{h}} 41^{\text{m}} 48^{\text{s}}$ : Dec. =  $+32^{\circ} 47'$ . Herschel's declination is too large, as this is S. 726, the place of which, from *Positiones Medice*, is:—R.A. =  $19^{\text{h}} 41^{\text{m}} 59^{\text{s}}$ : Dec. =  $+32^{\circ} 36'$ .

H. N. 112.

No measures. The polar distance in the Catalogue is  $19^{\circ} 4'$ , which, as corrected by Herschel, should be  $99^{\circ} 4'$ . This makes it identical with  $\Sigma 3008$  (= S. 829), the places agreeing very nearly. This pair is now a well-recognised binary. It is B.A.C. 8154.

H. N. 127.

The place given is the same as that of H. VI. 4 ( $\alpha^2$  *Capricorni*), while H. VI. 92, which is described as in or near the place of H. N. 127, is  $30'$  north and  $5^{\text{m}}$  preceding. Referring to Sir William Herschel's original Catalogue, I find this designated as "the middle one of 3, *n f a Capricorni*."

H. N. 129.

R.A. =  $18^{\text{h}} 57^{\text{m}}.5$ : Dec. =  $-22^{\circ} 54'.9$ . No measures; Class I. This is L. 35530, from which its place is:—R.A. =  $18^{\text{h}} 56^{\text{m}} 0^{\text{s}}$ : Dec. =  $-23^{\circ} 4' 31''$ . My estimates of angle and distance are as follow:— $P=300^{\circ}$ :  $D=8''$ : Mags.  $7\frac{1}{2}$ , 10.

## H. N. 130.

Class I. I have not been able to find any double star of the first class in this place.

## H. N. 131.

"Unidentifiable; Class III." R.A. =  $21^{\text{h}} 49^{\text{m}} \pm$ : Dec. =  $-15^{\circ} 6' \pm$ . Although the difference in declination is considerable, I have no doubt, after a careful search, that this pair is the same as H. 3071, the place of which is:—R.A. =  $21^{\text{h}} 51^{\text{m}} 14^{\text{s}}$ : Dec. =  $-15^{\circ} 42'$ . Herschel gives of this, P =  $318^{\circ} 5$ : D =  $18''$ : Mags. 8, 11. "Fine." There is a  $20''$  pair of 12 m. stars (H. 5522, *Cape Observations*) very near the place of H. N. 131; but from the faintness of both stars it is too insignificant an object to make it at all probable that it is the pair discovered by Herschel I.

## H. N. 139.

R.A. =  $21^{\text{h}} 12^{\text{m}} 1$ : Dec. =  $-15^{\circ} 48'$ . No measures; Class I. This place is also largely in error if the double found is the one in question. The only double of Class I. found after a careful search and examination of all the stars near, is L. 41483. It is a beautiful and interesting pair. My estimates of position and distance are:—P =  $100^{\circ}$ : D =  $1'' 5$ : Mags. 8, 10. Its place from Lalande is:—R.A. =  $21^{\text{h}} 15^{\text{m}} 39^{\text{s}}$ : Dec. =  $-15^{\circ} 26'$ .

## H. N. 140.

R.A. =  $22^{\text{h}} 37^{\text{m}} 1$ : Dec. =  $-5^{\circ} 30'$ . Class II. I have not examined this star. Struve, in *Positiones Medice*, gives its place:—R.A. =  $22^{\text{h}} 35^{\text{m}} 51^{\text{s}}$ : Dec. =  $-5^{\circ} 44'$ , which is probably correct.

Chicago, U.S., 1873, December 8.

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*On Red Stars in Cygnus.* By G. F. Chambers, Esq.

In Vol. xxxiv. of the *Monthly Notices*, p. 54, I observed some remarks by Mr. J. Birmingham concerning Red Stars catalogued by Schjellerup, on which I should like to say a few words, for Red Stars have long interested me, and I have paid much attention to them. It was on this account that I incorporated Schjellerup's list into my *Descriptive Astronomy*, making however some additions to it. After the publication of the Catalogue in that work, I resolved upon undertaking an examination on my own account of every star contained therein which was visible in England, with